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The role of job strain in understanding mid-life common mental disorder: Evidence from a national birth cohort study

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Abstract

Background: There are long-standing concerns about reverse causation and residual confounding in the prospective association between job strain and risk for future Common Mental Disorders (CMDs).

Methods: Data from the National Child Development Study ($n = 6870$) were analysed using multivariate logistic regression to investigate the prospective association between job strain variables at age 45 years and risk of future CMDs at age 50 years, controlling for lifetime psychiatric history and a range of other possible confounding variables across the life-course. Population attributable fractions (PAFs) were calculated to estimate the public health impact of job strain on mid-life mental health.

Findings: In the fully adjusted model, high job demands (OR = 1.70, 95% CI = 1.25 – 2.32, $p=0.01$), low job control (OR = 1.89, 95% CI = 1.29 – 2.77, $p<0.01$), and high job strain (OR = 2.22, 95% CI = 1.59 - 3.09, $p<0.01$) remained significant predictors of future CMD onset. Fourteen percent of new CMD cases could have been prevented through elimination of high job strain (PAF = 0.14, 95% CI = 0.06 – 0.20).

Interpretation: High levels of job strain appear to have an independent influence on the risk of future CMDs in midlife. These findings suggest that modifiable work-related risk factors may be an important target in efforts to reduce rates of CMDs.

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Keywords: Work; Job strain; Demand-control Model; Work Stress; Mental Health; Common Mental Disorders

Introduction

Mental ill-health has now become the leading cause of sickness absence and long-term incapacity in most high-income countries ¹, which has led to increased academic, policy, and public attention on the relationship between job characteristics and mental health ¹⁻⁵. The most widely-studied and influential theoretical model in this field is Karasek's ⁶ job demands-control model. This model holds that high job demands (including work pace, intensity, and conflicting demands) and low job control or decision latitude (including workers' ability to make decisions about their work) engender a state of high job strain, which places workers at elevated risk for health problems ⁶. Demonstrating this theorised causal relationship in relation to common mental disorders (CMDs) would provide a strong basis for targeting job strain in work-based mental health prevention programs ^{7,8}. However, previous attempts to establish this relationship have been severely challenged by the possibility of reverse causation and residual confounding.

Associations between high job demands, low job control, and high job strain with CMD symptoms have been uncovered in decades of cross-sectional research, most notably in large population studies such as the British Whitehall study ⁹, the Belgian BELSTRESS study ¹⁰, the Dutch NEMESIS-2 study ¹¹, the Norwegian HUSK study ¹², and the Australian PATH 40+ study ¹³. While longitudinal studies in this field are less common, they have generally produced similar results to the cross-sectional research, even across a range of follow-up periods. In the French GAZEL study, job demands and job control predicted subsequent depressive symptoms over a one-year period ¹⁴. In the British Whitehall study, job demands and job control predicted subsequent psychiatric morbidity over a five-year period ¹⁵. Over a still longer period, in the Belgian BELSTRESS study job demands (among men), job control (among women), and job strain (for both genders) showed unadjusted associations with subsequent depressive symptoms over a seven-year period¹⁶. Consistent with those results, major meta-analyses and systematic reviews of the longitudinal evidence have found

evidence of effects of job demands, job control, and job strain on risk of subsequent depression,¹⁷ and on risk of CMDs more generally^{4,18}. More recent prospective studies have shown that these associations are similar in nature, regardless of whether depression is measured via self-report symptom inventories or diagnostic interviews.¹⁹

While the association between job strain and CMDs is well-established, there remain several major barriers to causal interpretations. The first concern is that of reverse causation. While the job demands-control model implies that adverse job characteristics cause deterioration in mental health⁶, it is also possible that those with emerging poor mental health are disadvantaged in the labour market and are consequently overrepresented in less desirable jobs¹. Individuals who already have a history of CMDs may also be more likely to perceive equivalent jobs more negatively, as consistent with the negative cognitive biases associated with depression and anxiety disorders. While cross-sectional studies provide no information about the order in which job strain and CMDs emerge, longitudinal studies in this field have attempted to address the possibility of reverse causation by excluding psychiatric cases and/or controlling for psychiatric symptoms at baseline. It remains possible, however, that psychiatric symptoms earlier in life may be in remission and hence go undetected (and uncontrolled) at baseline, while nonetheless affecting education, career trajectories, and job ratings.

A second concern is that of residual confounding: a third variable acting as a common cause of actual or perceived job characteristics and CMD. A wide range of non-workplace mental health risk factors may be associated with self-reported job characteristics, such as socio-demographic variables, childhood intelligence, temperament, and stressful life events (SLEs). Indirect evidence for such confounding comes from Henderson et al.'s²⁰ finding that the apparent prospective relationship between job control and subsequent sickness absence was eliminated after controlling for childhood IQ and education. Some longitudinal studies, such as the BELLSTRESS study, have found that prediction of depression symptoms by job

strain was reduced to marginal significance once adjustment was made for age, education level, social network, satisfaction with private life and locus of control ¹⁶. In spite of these isolated findings, Bonde's ²¹ review of the literature on job strain and depression found that very few published studies controlled for multiple confounding variables across different domains and age periods.

The present study aimed to address concerns about reverse causation and residual confounding through analysis of data collected in the UK National Child Development Study (NCDS), a large British cohort study ²². This dataset provides a unique opportunity to address these issues by examining the prospective relation between job strain and CMD onset while controlling simultaneously for psychiatric symptoms measured at multiple time-points, as well as a comprehensive set of other potential confounding variables recorded across the lifespan. The existence of job strain as a potentially modifiable causal factor of CMDs would have significant public health implications, as well as substantial economic consequences for employers.

Method

Participants

The 1958 Birth Cohort (National Child Development Study, NCDS) includes 17,205 (98%) births in the UK during the week of 3-9 March 1958. Data were obtained from cohort members as well as their parents, schools, and medical officers at ages 7, 11, 16, 23, 33, 42, 45, and 50. The study is described in detail elsewhere ²².

The overall study design and flow of participants through the various assessments is shown in **Figure 1**. The base population for this study included 9377 participants who participated in the survey at age 45 years. Of these, 8417 individuals (90%) completed the self-completion questionnaires required for inclusion in this study. In order to obtain a cohort of working individuals free of depressive symptoms at baseline (aged 45), we excluded

participants who reached the threshold for CMD caseness, as defined by a Clinical Interview Schedule Revised (CIS-R) score of 12 or higher ($n = 556$)²³ at age 45. The CIS-R is a structured interview that enquires about symptoms of depression and anxiety disorders over the previous month and has been validated against more rigorous clinician diagnostic scales.²⁴ At age 45, participants were also asked, “Are you in paid work either full or part time?” and were able to respond “yes” or “no”. Those who indicated that they were not in paid employment at age 45 ($n = 696$) were also excluded. We further removed individuals who changed employers between age 45 and 50 ($n = 295$), leaving a final analytic sample of 6870 participants. Between 45 and 50 years, 775 (11%) participants in the analytic sample were lost to follow-up, meaning prospective data was available on 6095 participants. Of these, 6060 respondents had data on CMD caseness, yielding a follow-up rate of 88.2%. Previous analyses have demonstrated that the 45-year old sample is largely representative of the original birth cohort, although some disadvantaged groups have suffered a disproportionate loss to follow-up, in particular non-white participants, those from manual class backgrounds, whose mother did not remain in school, or who lived in rented housing.²⁵

Ethics approval for the study was granted by the South East Multi-Centre Research Ethics Committee (ref: 01/1/44), and participants provided written informed consent after receiving a complete description of the study.

Measures

Job strain variables

At age 45, job strain variables were measured using items derived from the Whitehall II Study questionnaire²⁶, and based on Karasek’s Job Content Questionnaire (JCQ)⁶. The job control subscale comprised three items measuring decision authority (ability to make decisions about work) and three items measuring skill discretion (opportunity to utilise skills during work). The job demands subscale comprised four items that inquired about work pace,

intensity, and conflicting demands. These 10 items were selected since they had the strongest correlations with the corresponding total subscale scores in previous research ²⁶. Previous research has shown similar associations between self-report and objective measures of job demand and job control ²⁷. Participants responded to each item on a 4-point Likert scale. Certain responses were reverse-scored so that higher summed subscale scores indicated higher job demands or job control. In the present study, there was acceptable reliability for both the job demands (Cronbach's $\alpha = 0.69$) and job control (Cronbach's $\alpha = 0.79$) subscales. In line with previously published studies which have used the same questions to assess job demand and control, the scores for these subscales were divided into tertiles (low, medium and high scores) ^{26,28,29}. A job strain measure was computed by combining the job demands and control subscales as shown in **Figure 2**, producing nine exposure categories which were further classified into 3 levels of job strain: low, intermediate and high.

Common mental disorders

The 9-item psychological subscale of the Malaise Inventory ³¹ was used to detect case-level CMDs at age 50. The psychological subscales of the Malaise Inventory are commonly used in health surveys and have previously been shown to be validated methods of discriminating those with recent psychiatric morbidity ³². Each question enquires about symptoms of depression or anxiety, for example, “Do you often feel depressed?” and “Do you often get worried about things?”. For each question, a score of 1 was assigned to a ‘yes’ response and 0 otherwise, and from this a total score ranging between 0 and 9 was generated. Following previous use of this subscale ³³, a score of 4 or higher was considered indicative of case-level symptoms of CMD. In the case of missing data in some but not all items, individuals were only excluded where sufficient missing values could potentially move them into the caseness category.

Adulthood covariates

A range of potential confounding variables were analysed as covariates. Each of these has previously been shown to be associated with future CMD and impaired occupational trajectories and therefore a greater chance of adverse work characteristics and job strain situations.^{29,34-36} Marital status at age 45 was grouped into five categories: single and never married, married or remarried, legally separated, divorced, and widowed. Highest educational attainment at age 33 was grouped into three hierarchical categories: no formal educational qualifications, 'O' levels (lower secondary education), and 'A' levels or higher (higher secondary education). Adult social position was represented by housing tenure at age 45 and occupational class at age 42. Housing tenure is indicative of material circumstances³⁷, and is classified according to whether the housing is owner-occupied (outright or with mortgage) or rented from a private or social landlord. Occupational class was categorised using the British Registrar General classification (I professional, II managerial/technical, III skilled, IV partly skilled, V unskilled)³⁸.

Psychiatric history was represented by case-level symptoms of CMD at ages 23 and 33. The full 24-item Malaise Inventory was completed by participants at both ages, but it was deemed appropriate to construct the malaise variables using the same 9-items included in the follow-up at 50 years. Consequently, a malaise score of 4 or higher out of a maximum score of 9 was considered indicative of case-level symptoms of CMD at ages 23 and 33.

Stressful life events (SLEs) at age 45 were measured as a comparison non-workplace predictor of mental health. These were measured using an extended version of the List of Threatening Experiences Questionnaire (LTE-Q)³⁰, which includes 16 items concerning adverse life events that occurred 6 months prior to the survey. The LTE-Q has demonstrated good validity and reliability, and has been recommended for use in psychiatric studies³⁰. As we aimed to examine *non-workplace* SLEs, the four items pertaining to employment were excluded from the summary score. Three other questions that were only applicable to cohort

members with partners were also excluded. The remaining nine items comprised questions on illness, separation from or serious problems within close relationships, death of a close family member or friend, financial problems, and experiences of assault. The number of life events was summed, and divided into three categories (0, 1, or 2 or more events).

Early life covariates

Childhood IQ was derived from General Ability test scores ³⁹ obtained at age 11. Adolescent temperament was reflected in school teacher ratings on a scale of 1 to 5 of participants' cautiousness, moodiness, timidity, flexibility, sociability, and laziness at age 16.

Statistical analysis

All data analyses were conducted using STATA version 12.0 (Stata, College Station, TX, USA). Weights were included throughout the analyses to control for disproportionate loss to follow-up amongst some groups. As in previous analyses of NCDS data ⁴⁰, inverse probability weights were calculated from predicted response probabilities, derived from a logistic regression model for follow-up. The prediction equation included the statistically significant predictors of response at age 50, and the effects of gender, social class, education, childhood IQ, and marital status. As no extreme weights were assigned to any individual, trimming was deemed unnecessary ⁴¹. Complete case analysis was also performed to ensure that results were not significantly altered by the application of inverse probability weighting.

The univariate associations between adulthood covariates (socio-demographic factors, psychiatric history), early life covariates (childhood IQ and adolescent temperament), and the job strain variables were explored using logistic regression (cumulative logit) with the three level job strain variable as the dependent variable in all models. Univariate logistic regression models were also applied to investigate the relationships between the covariates and case-

level symptoms of CMD at 50 years. The CMD caseness variable was binary, and was defined as a score of 4 or higher on the Malaise Inventory, which had possible scores ranging from 0 to 9. Multivariate logistic regression was performed to test the prediction of CMD caseness by the job strain variables and non-workplace SLEs, adjusting for each other and for the covariates entered into the models in a sequence identified *a priori*. The order in which the covariates were entered followed the sequence of events within this life course data, such that after socioeconomic factors, early life factors were entered first, followed by young adult events and then mid-life factors. Specifically, sociodemographic (gender, marital status) and socioeconomic (housing tenure, occupational class, highest education) were entered first (Model 2), followed by early life factors (1Q at age 11, temperament at age 16) in Model 3. Past psychiatric problems (CMD at ages 23 and 33) were included in Model 4, and adult non-work stressful life events were controlled for in the final model (Model 5) along with all the other potential confounders. Because some previous studies have suggested differing relationships between work and mental health depending on gender or social class¹⁶, for all analyses, two-way interactions between gender and occupational class and job strain and CMD were tested with the inclusion of a multiplicative two-way interaction term in the regression models. Stratified analysis was only performed if significant two-way interactions were detected. Population attributable fractions (PAF) were computed using the *punaf* command in STATA, which utilises the normalizing and variance-stabilising transformation statistical method.

Role of the funding source

The funders of the study had no role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; and in the decision to submit the paper for publication. The corresponding author had full access to the data in the study and had final responsibility to submit the paper for publication.

Results

Baseline characteristics of the analytic sample are shown in **Table 1**. Missing data regarding job strain was present in 3.6% of participants, while 2% had missing data on non-workplace SLEs and 0.6% of those followed had missing data on CMD caseness at age 50. . There was disproportionate loss to follow-up at age 50 amongst males, unmarried individuals, and those with lower social class, education, and childhood IQ.

As expected, significant associations were found between job strain and the potential confounding variables of gender, occupational class, education, childhood IQ, psychiatric morbidity at 23 years and 33 years, non-workplace SLEs ($p < 0.001$ for all), and the adolescent temperaments of being more timid and hardworking ($p = 0.03$ for both). CMD caseness at age 50 was also associated in the expected direction with the potential confounding variables of gender, housing tenure, occupational class, education, IQ, psychiatric morbidity at 23 years and 33 years, and higher moodiness ratings at 16 years ($p < 0.03$ for all). Furthermore, CMD caseness in early adult life was associated with later measures of job control, job demands, job strain, and non-workplace SLEs ($p < 0.002$ for all). All variables were therefore included as covariates in the multivariate analyses as planned *a priori*.

Table 2 presents the ORs and 95% CIs for CMD caseness at 50 years as predicted by the job strain variables at age 45 years. The weighted incidence rate of CMD caseness at follow-up was 10.2%. In the unadjusted model, lower job control, higher job demands and higher job strain were each individually associated with greater odds of displaying case-level CMD symptoms at follow-up (p -trend < 0.001 for all). Confounding effects of socio-economic characteristics (Model 2) and early life factors (Model 3) explained a substantial amount of the overall effects; inclusion of past psychiatric problems (Model 4) in the regression model further attenuated the associations. The final model (Model 5) controlled

for the potential confounders listed above, and mutually adjusted for work-related factors and life events. Although the effect sizes were attenuated, the significant positive associations between the odds of CMD caseness and low job control (OR=1.89; 95% CIs=1.29, 2.77; p -trend <0.001), high job demands (OR=1.70; 95% CIs=1.25, 2.32; p -trend =0.001) and high job strain (OR=2.22; 95% CIs=1.59, 3.09; p -trend <0.001) remained significant. There were no significant two-way interactions between gender or occupational class and job strain on CMD (p >0.05 for all). Based on the final multivariate model, the population attributable fractions (PAFs) for job strain were calculated. In order to calculate the PAF for high job strain situations, the low and medium job strain categories were combined. This allowed a calculation of how many cases of new CMD could have been avoided if all of the individuals reporting high job strain (26%) could have been moved into the combined low and medium job strain group. Assuming causality and a lack of residual confounding, fourteen percent of new CMD cases could have been prevented through elimination of high job strain (PAF=0.14, 95% CI=0.06, 0.20).

All analyses were repeated on the original, unweighted data (not shown), but the results did not substantially differ from the weighted estimates. We also repeated our analyses post hoc with log-binomial regression, in order to compare the effect size estimates when presented as risk ratios rather than odds ratios. While the multivariate models were unable to converge, the univariate models provided very similar effect sizes to logistic regression (risk ratio for low job control compared to high job control 2.36, 95% CI 1.82, 3.06, p <0.001, risk ratio for high job demand compared to low job demand 1.60, 95% CI 1.31, 1.97, p <0.001 and risk ratio of high job strain compared to low job strain 2.72, 95% CI 2.16, 3.44, p <0.001).

Discussion

While the presence of a prospective association between job strain and CMDs has been well-established^{18,21,42}, substantial doubts about the true nature of this relationship have remained due to concerns about possible reverse causation and residual confounding⁴. The present study has analysed life-course data to show that job demands, job control, and job strain have a prospective impact on risk of future CMD onset independent of lifetime psychiatric history and other potential confounding variables across the lifespan. The models produced in this study are the most complete, in terms of taking account of potential confounding, to ever be published and allowed us to determine an accurate estimate of the mental health impact of job strain at a population level. Our models suggest that up to 14% of CMD cases in this cohort were potentially preventable with the elimination of job strain situations. Such estimates have important caveats, most notably an assumption of causation and a lack of any residual confounding. However, given the complexity of the models presented in this paper, this population attributable fraction suggests that job strain is an important modifiable risk factor for public mental health interventions to be addressing.

The finding that lower job control, higher job demands, and higher job strain each predicted increased risk of future CMDs at five years follow-up corroborates reports that the job strain variables were associated with CMDs cross-sectionally in large population studies⁴², as well as prospectively in longitudinal studies^{18,21}. Importantly, the use of life-course data enabled us to extend beyond previous research by more rigorously controlling for lifetime psychiatric history and other early life factors. Previous studies typically only controlled for psychiatric symptoms at baseline, such that earlier psychiatric symptoms in remission may have gone undetected and uncontrolled. By contrast, the present study not only excluded participants meeting the threshold for psychiatric caseness at baseline, but also controlled for psychiatric morbidity as measured at two earlier points in each individual's life. Furthermore, our use of life-course data enabled simultaneous control for an extensive set of other variables that could act as a common cause of both self-reported job

characteristics and risk of CMDs, including childhood, adolescence, and adulthood variables. The childhood and adolescence covariates in particular have rarely been controlled for in previous studies. Through these innovations, the present study constitutes the most rigorous attempt to date to address concerns about reverse causation and residual confounding. Consequently, the present results permit several new conclusions to be drawn.

First, while reverse causation and residual confounding may contribute to the observed association between job strain variable and CMD, these issues do not entirely account for the relationship. As such, the present findings strengthen the evidence that job strain has an independent causal impact on CMD onset, as postulated in Karasek's ⁶ classic demands-control model. Second, comparison of effect sizes from our models suggests that low job control may exert a stronger independent influence on CMD onset than high job demands. The particular importance of job control as a causal factor is consistent with evidence of reduced CMDs following workplace interventions that improve employee control ⁴³. This importance may reflect the conceptual link between low job control and low perceived control. Low perceived control is an important transdiagnostic vulnerability factor for several CMDs.

Our study also has important limitations. The chosen method of analysis for our nested-case control study was logistic regression. While appropriate for this study design, logistic regression can inflate effect sizes compared to other types of analysis that produce risk ratios. In order to explore this possibility, we re-ran our analyses post hoc with log-binomial regression. While the multivariate models were unable to converge, the univariate models provided very similar effect sizes to those reported with logistic regression. Failed conversion of multivariate log-binomial regression models is not uncommon. This results from the maximizing process failing to find the maximum likelihood estimate, which does not imply any lack of significance of the underlying relationship of interest, but rather the mathematical complexities of working with probabilities within a log-link function. As with

many studies in this field, self-report measures were employed to assess both job strain and CMDs. Consequently, common method factors may have inflated the associations between these variables. However, the adjustment for several potentially relevant variables (e.g., childhood temperament) may have gone some way to mitigating this risk. While an extensive set of covariates were controlled for in order to limit overestimated associations, some residual confounding remains possible, particularly from variables such as physical health, substance misuse and family psychiatric history. Residual confounding is also a possibility due to misclassification of the measured confounders. For example, the personality measures obtained may not have adequately captured all the personality traits, which may be relevant for the associations under investigation. We also note that this study only examined job strain and that other work-related risk factors for CMDs, such as effort-reward imbalance and job insecurity, may have a role as residual confounders. The pattern of exposure to job strain over time, in particular the chronicity of any exposure, may also be important. A related limitation is that our sample was selected to be in employment and without any evidence of mental ill health at baseline (45 years). As a result, it is likely that some individuals who were more prone to mental disorder would have been excluded on the basis of their symptoms or the fact that their prior illness may have contributed to them leaving the workforce. This will have led to our sample potentially being more resilient, an issue often termed the ‘healthy worker effect’, which may have resulted in an underestimate of the impact of job strain on mental health. Additionally, in spite of our attempts to define a sample without mental health symptoms at baseline and to control for prior mental health problems, it remains probable that some of our sample would have had prior mental disorder which was well controlled at each assessment. This means that an element of reverse causation may remain in our final models.

Other factors may have contributed to underestimation of the true effect of job strain. Since the outcome was future CMDs at a single five-year follow-up, the analyses were

insensitive to psychiatric consequences of job strain that emerged after the baseline measure but subsided before the follow-up. There are also limitations to the study's external validity. While the base sample was large and generally representative of the UK population, there was evidence of differential attrition, with only 8417 (48%) of the original sample recruited at birth providing valid responses at age 45. In spite of this, previous analyses have demonstrated that the 45-year old sample remains largely representative of the original birth cohort, although some disadvantaged groups have suffered a disproportionate loss to follow-up, in particular non-white participants, those from manual class backgrounds, whose mother did not remain in school, or who lived in rented housing.²⁵ While weighting was used in the analysis to address this concern, such weighting can only consider predictors of attrition measured at baseline. This means that factors that may have impacted on attrition but which occurred after baseline, for example emerging mental health problems, could not be accounted for. As in all birth-cohort studies, these results are also subject to cohort effects, and may be age-specific. For example, while job control appeared to be a particularly important influence on mental health in this cohort, this may not generalise to younger workers for whom relatively low job control may be more acceptable given their early career status. Moreover, since the cohort members were all British and were surveyed during the 2008 global financial crisis, the present results may not generalise to workers of other nationalities or to time periods of differing job security.

Since data were not collected concerning temporal patterns of exposure to job strain (e.g., gradual vs. sudden onset, acute vs. chronic exposure), it is unclear from these results whether some patterns of exposure have particularly deleterious effects on mental health. For example, the BELLSTRESS study indicated that repeated job strain has an especially strong adverse impact on mental health, compared to less chronic strain¹⁶. In spite of these limitations, the present study has highlighted the potential public health impact of addressing job strain factors in the workplace. Previous research on interventions aimed at increasing

employee control ^{43,44} or improving job design ^{45,46} has shown some promise in promoting mental health and reducing stress in the workplace. The next step in attempting to capitalise on this potential is for more methodologically rigorous evaluation of workplace interventions focused on these modifiable risk factors.

Authors and contributors: SBH, MH, SLH, and AM had the original idea for the study and formulated the analysis plan. SBH and M-JW acquired the data. SBH, DAS, and M-JW did the statistical analysis. SBH, DAS, and M-JW drafted the manuscript, which was revised for additional interpretation by all authors. SBH is guarantor.

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Table 1*Baseline Characteristics of the Analytic Sample*

Characteristics	n	(%)^a
Gender		
Male	3534	(52)
Female	3336	(48)
IQ at 11y (general ability test score)		
Quartile 1 (0 - 36)	1564	(27)
Quartile 2 (37 - 48)	1548	(26)
Quartile 3 (49 - 58)	1436	(23)
Quartile 4 (59 - 79)	1442	(24)
Temperament at 16y^b		Mean (SD)*
Cautious vs. impulsive	2.73	(0.88)
Moody vs. even-tempered	3.64	(1.16)
Timid vs. aggressive	2.92	(0.71)
Flexible vs. rigid	2.74	(0.78)
Sociable vs. withdrawn	2.31	(1.02)
Lazy vs. hardworking	3.40	(1.18)
CMD at 23y		
No	5567	(93)
Yes	396	(7)
CMD at 33y		
No	5926	(96)
Yes	272	(4)
Highest educational level at 33y		
No formal educational qualifications	1170	(20)

O levels	2085	(34)
A levels or higher	2837	(46)
Occupational class at 42y		
I (Professional)	392	(5)
II (Managerial/technical)	2592	(38)
III (Skilled)	2730	(42)
IV (Partly skilled)	816	(12)
V (Unskilled)	195	(3)
Housing tenure at 45y		
Own outright or mortgage	6048	(88)
Rent or other arrangements	785	(12)
Marital status at 45y		
Single never married	675	(10)
Married or re-married	5069	(74)
Legally separated	172	(3)
Divorced or widowed	905	(13)
Adult life events		
0	4008	(59)
1	1758	(26)
2 or more	969	(15)

^a Weighted percentages or weighted means (and unweighted standard deviations).

^b Higher scores represent inclination towards right-hand temperament.

Table 2

Associations between the Job Strain Variables at 45 years and New Onset CMD Caseness at 50 years using Logistic Regression

Workplace factors	n (%) ^a	Model 1 (Crude)		Model 2 (+ gender, SES)		Model 3 (+ early life factors)		Model 4 (+ psychiatric history)		Model 5 (+ adult life events)	
		OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>
Job control											
Low	2212 (33)	2.58 (1.95 - 3.42)	<0.001	2.14 (1.58 - 2.92)	<0.001	2.18 (1.54 - 3.08)	<0.001	1.93 (1.32 - 2.81)	0.001	1.89 (1.29 - 2.77)	0.001
Medium	2991 (44)	1.61 (1.22 - 2.13)	0.001	1.44 (1.07 - 1.93)	0.016	1.31 (0.93 - 1.83)	0.12	1.20 (0.84 - 1.72)	0.31	1.21 (0.84 - 1.74)	0.31
High	1526 (23)	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Job demand											
Low	2893 (43)	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Medium	2056 (31)	1.52 (1.21 - 1.89)	<0.001	1.72 (1.36 - 2.18)	<0.001	1.40 (1.07 - 1.84)	0.015	1.25 (0.93 - 1.69)	0.14	1.25 (0.92 - 1.70)	0.15
High	1737 (26)	1.69 (1.35 - 2.12)	<0.001	2.03 (1.58 - 2.60)	<0.001	1.76 (1.33 - 2.33)	<0.001	1.69 (1.25 - 2.29)	0.001	1.70 (1.25 - 2.32)	0.001
Job strain											
Low	2153 (33)	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Medium	2698 (41)	1.81 (1.40 - 2.34)	<0.001	1.67 (1.28 - 2.18)	<0.001	1.64 (1.21 - 2.22)	0.001	1.49 (1.08 - 2.05)	0.014	1.54 (1.11 - 2.13)	0.01
High	1768 (26)	3.04 (2.35 - 3.92)	<0.001	2.80 (2.14 - 3.66)	<0.001	2.59 (1.91 - 3.52)	<0.001	2.29 (1.65 - 3.17)	<0.001	2.22 (1.59 - 3.09)	<0.001

^a Weighted percentages.

Model 1: Crude.

Model 2: Adjusted for gender, housing tenure, occupational class, marital status, and highest education at 33

Model 3: Adjusted for gender, housing tenure, occupational class, marital status, highest education at 33, IQ at 11y, and temperament at 16y.

Model 4: Adjusted for gender, housing tenure, occupational class, marital status, highest education at 33, IQ at 11y, temperament at 16y, CMD at 23y, and CMD at 33y.

Model 5: Adjusted for gender, housing tenure, occupational class, marital status, highest education at 33, CMD at 23y, CMD at 33y, IQ at 11y, temperament at 16y, and adult non-work life events.

Research in Context

Evidence before this study

Mental ill-health has now become the leading cause of sickness absence and long-term incapacity in most high-income countries, which has led to increased academic, policy, and public attention on the relationship between job characteristics and mental health. Karasek's job demands-control model is the most widely studied and influential theory in this field, and the association between high job strain and common mental disorders (CMD) has been well-established in decades of cross-sectional and longitudinal research. However, there remain serious barriers to casual interpretations, namely reverse causation and residual confounding. For the purposes of a recently published systematic meta-review, we searched MEDLINE, PsycINFO, Embase, the Cochrane Collaboration, and grey literature databases until 4 April 2016, with search terms including "mental health", "work", and "review". This search identified 6 systematic reviews and/or meta-analyses that examined the association between job strain and CMD. These reviews found that very few published studies controlled for lifetime psychiatric symptoms and/or multiple confounding variables across different domains and age periods.

Added value of this study

Our findings show that high job demands, low job control, and high job strain have a prospective impact on risk of future CMD onset, independent of lifetime psychiatric history and other potential confounding variables across the lifespan. Moreover, 14% of CMD cases are potentially preventable with the elimination of high job strain situations.

Implications of all the available evidence

The models produced in this study are the most complete, in terms of taking account of potential confounding, to ever be published, and suggest that job strain is of substantial public health significance. This has important implications for the development of workplace interventions, as targeting modifiable work-related risk factors, such as high job strain, may help to reduce rates of CMD in the general population.